MOTION DETECTION FOR PC BASED SECURITY SYSTEM BY USING OPTICAL FLOW

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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Electronics)"

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ABSTRACT

This system will detect and analyze the motion of people that recorded on PC then gives the feedback on the spot if there have an abnormal motion. Horn-Schunck method is one of optical flow method which is a method or technique to detect the motion in an image sequent. By this method, the we can know the velocities of motion object in the image sequent. Afterward, velocities will be analyze to determine object movement. Hence, if there is abnormal motion, this system will give the alert. The efficiency of this sytem are 81%.

ABSTRAK

Projek ini membina satu sistem bagi pengesan pergerakan melalui komputar persendirian berdasarkan sistem keselamatan dengan menggunakan Aliran Optik. Sistem ini akan mengesan dan menganalisis pergerakan manusia yang dirakam dari komputer persedirian. Kaedah Horn-Schunck merupakan salah satu kaedah Aliran Optik di mana ianya merupakan kaedah atau teknik untuk mengesan pergerakan di dalam satu urutan gambar. Melalui kaedah ini, kita akan mengetahui kelajuan pergerakan objek yang terdapat di dalam urutan gambar tadi. Kemudian, nilai kelajuan akan dianalisis untuk menentukan pergerakan objek. Maka, jika terdapat pergerakan tidak normal, sistem ini akan memberikan amaran. Kecekapan sistem ini adalah sebanyak 81%.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

This project concerns with the development of a system whereby motion detection for PC based security system using optical flow. One of the product or method for security system is closed-circuit television (CCTV). The existing CCTV is only for monitoring and observe as well as record the activities. My project is a system that put some intelligent on the function of closed-circuit television (CCTV).

This system will detect normal and abnormal motion of the a movement that recording by CCTV from PC by use algorithm technique development using optical flow. Then, this system will give the feedback on the spot by giving alert. Alert will be given if there is any detection of abnormal motion. Normal motion is consider as people walk. In contrast, abnormal motion consider people run at the same place or place.

1.2 Optical Flow Method

Optical flow is a useful method in the object tracking branch and it can calculate the motion of each pixel between two frames, and thus it provides a possible way to get velocity of the motion object [1]. It is the apparent motion of the brightness pattern in an image sequence.

Optical flow technique is the most popular technique using by engineer to detect motion. This project will use one of optical flow method which is Horn-Schunck method. This method is global approach that more sensitive to noise. By using this method, we can evaluate the velocity of the pixel moving across the one image into the next image in a sequence.

1.3 MATLAB

This project use MATLAB software to apply the optical flow method. This software is high-level technical computing language and interactive environment for algorithm development, data analysis, and numeric computation. Applying optical flow method program, the image capture by CCTV can be analyzed by using this software. So, we can know either there has abnormal or normal motion from the a movement that capture by CCTV from the analysis.

1.4 Problem Statement

The existing CCTV is only for monitoring and observe as well as record the activities, it does not give a lot of help while any crime happen. Criminals still free outside there because there are a lots of crime never get the solution. Usually, there will be delay in action when the crime occur such as police will arrive after the crime happen.

Then, to find the criminal, the scene that record by CCTV will be analyze and diagnosis. While waiting for result of the diagnosis, there are a lot of procedure waiting for result approval and without knowing, criminal will done more crime or they can grab the opportunity to find a solution that is not charged as a criminal.

In order to analyze the recorded activities as well can give the result on the spot, optical flow method use to analyze the motion. This method can be use to differentiate the movement pattern. The pattern of criminal movement are different from normal person movement. So, the movement pattern can be classify into two categorize which are abnormal and normal motion. An analysis should be done to differentiate the movement pattern.

1.5 Objectives

The objectives of the project that need to be achieved are:

i. To detect the suspicious and abnormal motion from a movement using optical flow method
ii. To apply optical flow in image processing analysis

1.6 Scope of Project

The scopes of this project are:

i. To apply the optical flow method which is Horn-Schunck method in MATLAB software.
ii. To relate the calculation using optical flow with the motion image.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will covered and summarize the content of the paper or presentation of conference, journal, research, report and any article that were studied related to the project. The content will give some overview about system and method that will use in this project. Some of studies give references in order to develop this project.

2.2 MATLAB

MATLAB stand for matrix laboratory is a technical computing environment for high-performance numeric computation and visualization. This software integrates numerical analysis, matrix computation, signal processing, and graphics in an easy-to-use environment where problems and solutions are expressed just as they are written mathematically which is without traditional programming [2].

This software also provide a product that acquire, process, and analyze images and video for algorithm development and system design for image and video processing.

2.2.1 Pre-processing

The pre-processing performs some steps to improve the image quality or to enhance the data. This steps is needed to reduce the project assumption. For instance, if the project need to analyze iris but in the image not only the iris, but also some useless parts such as eyelid and pupil. Then, the camera to eye distance may also cause variations the size or angle or position of the same iris. Beside, image captured in low resolution, so it is hard to analyze the image as well as affect feature extracting. Therefore, it is necessary to do pre-processing the original images.[3]

2.2.2 Data acquisition

The first stage of any vision system is the data acquisition stage. The data can be image and video. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement [4]. Images are typically generated by illuminating a scene and absorbing the energy reflected by the objects in that scene.

2.2.3 Image processing

In computer vision, image processing is any form of signal processing for which the input is an image, such as a image or video (extract into frame). The output of image processing may be either an image or, a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two dimensional signal and applying standard signal-processing techniques to it.

In many cases, image processing concerned with taking one array of pixels as input and producing another array of pixels as output. This same as improving the array from the original array. By processing the input or data, this process may remove noise, improve the contrast of the image, removing blurring that caused by movement of the camera during image acquisition and as well as correct for geometrical distortions caused by lens [4].

2.2.4 Feature extraction

Feature extraction is a very important field with growing applications in science and engineering. The main aim of feature extraction is to extract important features from image data, from which a description, interpretation or understanding of the scene can be provided by the machine. When the input data to an algorithm is too large to be processed, then the input data will be transformed into a reduced representation set of features. Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy [5].

2.2.5 Classification

Image classification can be done after extract some features out of the image. Its analyze the numerical properties of various image features and organizes data into categories. In order to classify the image, two process are needed which are training and testing. Initially, training phase, characteristic properties of typical image features are isolated and, based on these, a unique description of each classification category is created. In the subsequent testing phase, these feature-space partitions are used to classify image features.[6] To demonstrate the performance of the learning algorithm, random data drawn from different classes were generated and used the proposed method to learn the parameters and to classify the data. [7]

2.3 Security system

Security system needed to ensure a safe places to live and used either in public or private. Airport, shopping center, financial institution, hospital and education institution are the area has a lot of people and crime occur easily. So, an efficient and good security system level play important role. In 2008, conference about Safety and Security System in Europe demonstrate exist security system that upgraded using Artificial Intelligent system.

Security guard responsible to protect or prevent crime happen, but their have limitation due to human strength and not able to describe criminal look like detailed [8]. Beside, not all security guard has certificate or knowledge or training about security. Closed-circuit television was developed initially as increasing the security and can give more information about crime happened.

2.3.1 Closed circuit television

Close circuit television (CCTV) security cameras play important role to give fairly strong and consistent evidence [9]. The images that we see from our eyes can as good as images that record by CCTV security cameras. The specification factor can effect the quality of camera images. Alarms can be embedded with CCTV in order to make the security system more efficient. The contribution made by combination of alarms and CCTV may be potential to increase numbers of detected cases [10].

The applications of image processing in CCTV make this system become more intelligent. Beside, use of image processing enables enhancements to many aspect such as attempt to avoid incident, detect ongoing incident in time to enable intervention as well as collect the evidence for post incident use. Also, improve edge

enhancement, for instance, make highlighted objects more easy recognizable. Make more stable in auto tracking white balance and not easy influenced by color objects in the scene [11].

2.4 Optical flow

The detection of moving objects is critical in many defense and security applications, where motion detection is usually performed in a pre-processing step, a key to the success in the following target tracking and recognition. Many videos used in defense and security applications are out-door videos whose quality may be degraded by various noisy sources, such as raining and wind [12].

Motion detection has been extensively investigated. In computer vision, motion is an important queue in order to used in tracking, structure from motion and video compression. Motion cannot be observe directly but we can observe image and see how points in the image move [13].

As one of the major techniques, optical flow-based approaches have been widely used for motion detection [12]. Optical flow will compute the velocity of the motion object between two consecutive frames of an image sequence. An image sequence is an ordered set of images and the velocity of the motion introduced in such an image sequence [14].

Optical flow is a method to detect motion which is a calculation method to detect the motion based on brightness and spatial smoothness. Optical flow-based approaches have been widely used and popular method use by engineer for motion detection [12]. So, it has a long history and assumptions of brightness constancy and spatial smoothness underlie most optical flow estimation methods [15].

Optical flow can arise from relative motion of objects and viewer, so it could

give important information about the spatial arrangement of the objects viewed and the rate of change of this arrangement [16]. Basically, optical flow is a velocity field of the image generated from the transformation of one image into the next image in a sequence [17]. Motion perceived when a changing picture is projected onto a stationary screen [17].

2.4.1 Optical flow exploration

Optical flow is a useful method in the object tracking branch and it can calculate the motion of each pixel between two frames [1]. A long history of optical flow estimation make have a lot of optical flow method have explored some variation of the same theme [15]. There are a lot of exploration describing the implementation of optical flow. Some result are acceptable, but in many project, there are limitations.

Most of the method or techniques exploit the two same constraints which are brightness constancy and spatial smoothness. The brightness constancy constraint is derives from the observation that surfaces usually persist over time and hence intensity value of a small region remains the same despite its position change. The spatial smoothness constraint come from the observation that neighboring pixel generally belong to the same surface and so have nearly the same image motion [15].

Since optical flow has been introduce, there have been a few effort to learn about the brightness constancy and spatial smoothness [15][18]. Recently, an adequately realistic image sequences with ground truth optical flow have been made and finally make this practical. A number of classic and recent optical flow has been revisit and the training data and machine learning methods that can be used to train has shown. From the advances have been made, there is a research go beyond previous formulations to define new versions of the data and spatial terms [15].

Recently advances have made two primary contribution which are exploit image intensity boundaries to improve the accuracy of optical flow near motion

boundaries and learn a statistical model of the data term. The idea to exploit image intensity boundaries is based on Nagel and Enkelmann who introduced oriented smoothness to prevent blurring of flow boundaries across image boundaries. The common brightness constancy assumption have addressed as a problems by several authors make the research want to learn about statistical model.[15]

The local image edge orientation was use in order to define a steered coordinate system for the flow derivatives. The flow derivatives along and across image boundaries that highly kurtotic are highlighted. Normally, the spatial smoothness of optical flow is expressed in term of the image axis aligned partial derivatives of the flow field. By using Markov random field and Gaussian scale mixture in flow field, a rigorous statistical formulation of the idea of Nagel and Enkelmann.[15]

With the intention of minimize the effects of illumination change, brightness constancy were extended to high-order constancy, such as gradient and Hessian constancy [2][19]. Furthermore, a research show that improving the accuracy of dense optical flow by integrating constraints within a local neighborhood [15][20]. Additionally, Field-of-Expert formulation has extended to the spatial-temporal domain to model-temporal changes in image features [15][18].

2.4.2 Problem and issues in optical flow

There are much progress has been made in optical flow computation and some issues have been made due to numerous theoretical and practical reasons [21]. Theoretically, optical flow is an approximation to image motion and largely determines the lower bound on accuracy. Beside, the scene properties such as occluding surface also make an issue in optical flow computation. Practically, based on a study by Barron et al in 1994, of computing optical flow that analyzed nine techniques based on accuracy and reliability of measurements[21][22].

Optical flow often misunderstood between image motion. The optical flow differ from image motion based on some conditions. In the case of the absence of texture, optical flow is zero and when true motion field violates the brightness consistency model used for its approximation [17][21]. Current optical flow methods mostly assume the uniform scene illumination and Lambertian surface reflectance are either explicitly or implicitly which use some form of the brightness consistency assumption [21].

Occlusion is difficult to analyze, despite the fact that occlusion constitutes an important source of visual information. The fact that image surfaces may appear or disappear in time, misleading tracking process and causing numerical artifact in intensity derivatives make occlusion difficult to handling. These problems have been express by research community. In optical flow, to determine the direction of translation and segment the scene into independently moving surface, the occlusion boundaries may be used [21]. Most of optical flow techniques relied on a single surface hypothesis which a rare visual event [17][21].

Hierarchical correlation methods is robust motion measurement schemes for image sequences with significant contrast change or large displacement and severe aliasing. Based on a study by Barron et al in 1994, the test image sequences used are all appropriately sampled with small motions (between one and four pixels per frame) and favorable to differential approaches. From their study, correlation methods experience difficulty with sub-pixel motions as their error depends on the closeness of the image motion to an integer number of the pixels. So, as the alternative of correlation methods is Hierarchical differential-based methods [22].

In case to threshold optical flow field or to weight velocities in post measurement processing such as in a motion and structure calculation, the confidence measures can be used. Confidence measures are needed to indicate the reliability of computed velocities [21]. Based on a study by Barron et al in 1994, the smallest eigenvalue of a least-square matrix were use although most of differential methods do not provide confidence measures [21][22].

2.4.3 Optical Flow previous work

Optical flow method have a lot of technique that introduced by researcher. Black and Anandan introduced a robust estimation framework to deal with such outliers, yet did not attempt to model the true statistics from example. Fermiller et al analyzed the effect of noise on the estimation of flow. However, they did not attempt to learn flow statistics of brightness computation [15].

Horn and Schunck introduced both the brightness constancy and the spatial smoothness constraints for optical flow estimation. In spite of this, their quadratic formulation assumes Gaussian statistics and is not robust to outlier caused by reflection, occlusion and motion boundaries as example [15][17].

The brightness constancy assumption have extended by many authors, either by making it more physically plausible or by linear or non-linear per-filtering of the images [15]. Recently the idea of assuming constancy of first or second image derivatives to provide some invariance to lighting changes with Laplacian pyramid has been updated [19]. The idea is connected by replaced the pixel-wise brightness constancy model with spatial smoothed one [20].

There are some problem encounter at motion boundaries where the assumption of spatial smoothness is violated. Nagel and Enkelmann introduced oriented smoothness to prevent blurring of optical flow across image boundaries by observing that flow boundaries often coincide with image boundaries. Then, some modification have made so that, less smoothing is performed close to image boundaries. Beside, the amount of smoothing along and across boundaries has been determined heuristically [15].

Lately, the spatial structure of optical flow field using a high-order MRF, called a Field of Expert and learned the parameters from training data. Roth and Black combined their learned prior model with a standard data term and found that